STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX A

DASIBI MODEL 1003 AH OZONE ANALYZER

MONITORING AND LABORATORY DIVISION

FEBRUARY 1995

TABLE OF CONTENTS

APPENDIX A

DASIBI MODEL 1003AH OZONE ANALYZER

TABLE OF CONTENTS (cont.)

APPENDIX A

DASIBI MODEL 1003AH OZONE ANALYZER

APPENDIX A

DASIBI MODEL 1003 AH OZONE ANALYZER

FIGURES

Page

TABLES

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX A.1

STATION OPERATOR'S PROCEDURES

FOR

DASIBI MODEL 1003 AH OZONE ANALYZER

MONITORING AND LABORATORY DIVISION

MARCH 1979

A.1.0 GENERAL INFORMATION

A.1.0.1 THEORY - The Dasibi ozone analyzer measures the amount of ultraviolet radiation absorbed by molecular ozone in a sample of ambient air. The quantity of light absorbed is proportional to the concentration of ozone in the air sample. A detailed discussion of the scientific basis of the analyzer measurement principle is contained in the Manufacturer's Instruction Manual.

This Appendix supplements the manufacturer's manual with instructions for servicing and troubleshooting the analyzer. Separate appendices are available for acceptance testing and calibrating the analyzer.

A.1.0.2 ANALYTICAL CYCLE* - The timing circuit board regulates the analytical cycle of the analyzer. The analytical cycle begins with the sample and control integrators zeroed and deactivated, and the memory circuit, digital display, and analog converter holding the values measured in the preceding cycle. The solenoid is then de-energized and sample air is drawn through the ozone selective zero filter (scrubber) into the absorption chamber. After the absorption chamber is purged with scrubbed air for about five seconds, the integrators receive the signal to start the count-up.

The sample and control integrators count each pulse from the sample and control electrometers, respectively, until the total number of counts (pulses) in the sample integrator equals the preset span number. The number of counts stored in the control integrator is proportional to the amount of ultraviolet (UV) flux (light) emitted by the UV lamp during the count-up.

After approximately 12 seconds, the solenoid is energized. The sample air then bypasses the scrubber and purges the absorption chambers. After about 5 seconds of purging, the integrators simultaneously receive signals to reverse integration (count-down). The integrators subtract each pulse received from the electrometers until the control integrator reaches zero counts, at which time counting of both integrators is terminated. Referencing the down count cutoff to the control counter assures that equal amounts of ultraviolet light enter the absorption chamber in both the zero (count-up) and the sample (count-down) modes of the analysis cycle. Thus, if any ozone is present in the sample air,

* Zero offset feature is not included in this section for simplicity's sake.

some of the ultraviolet light passing through the absorption chamber is attenuated and the sample integrator will contain counts at the termination of the analysis cycle. The analyzer span number is calculated so that the count remaining in the sample integrator at the end of the analysis cycle equals the air sample ozone concentration in parts per million (ppm). At the end of the count-down cycle, the counts remaining in the sample integrator are transferred to the memory, display, and digital to analog converter, the integrators are reset to zero, and a new sampling cycle is started.

A typical air sampling cycle is shown graphically and pictorially in Figure A.1.0.1.

A.1.0.3 CAUTIONS

1. Light from this analyzer's ultraviolet lamp can cause burns to the cornea. Use protective glasses to view the lamp or look at it only for a few seconds at distances of two or more feet.

2. This analyzer contains a 200 volt DC power supply and a 1400 volt AC supply. In addition, the lamp start-up voltages exceed 1000 volts. When working on this analyzer, use normal high voltage precautions.

3. Use a third wire ground on this analyzer.

4. Clean the optical tubes carefully to guard against damaging their teflon linings. The proper cleaning procedures are outlined in the Manufacturer's Instruction Manual.

GRAPHICAL AND PICTORIAL REPRESENTATION OF AIR SAMPLE CYCLE

1. Solenoid de-energized - absorption chamber cells purged with zero air (pulled through scrubber); sample and control integrators set to zero and memory circuit deactivated; digital display and D-to-A circuit holding value measured in previous cycle.
2. Integrators receive signal to count up.
3. Sample integrator to preset span setting - control integrator to UV lamp emission level.
4. Solenoid energized - abosrption tubes purged with sample air.
5. Integrators receive signal to count down.
6. Control integrator to zero - Sample integrator count equal to ozone present in sample air - memory, display and converter updated to new ozone value.

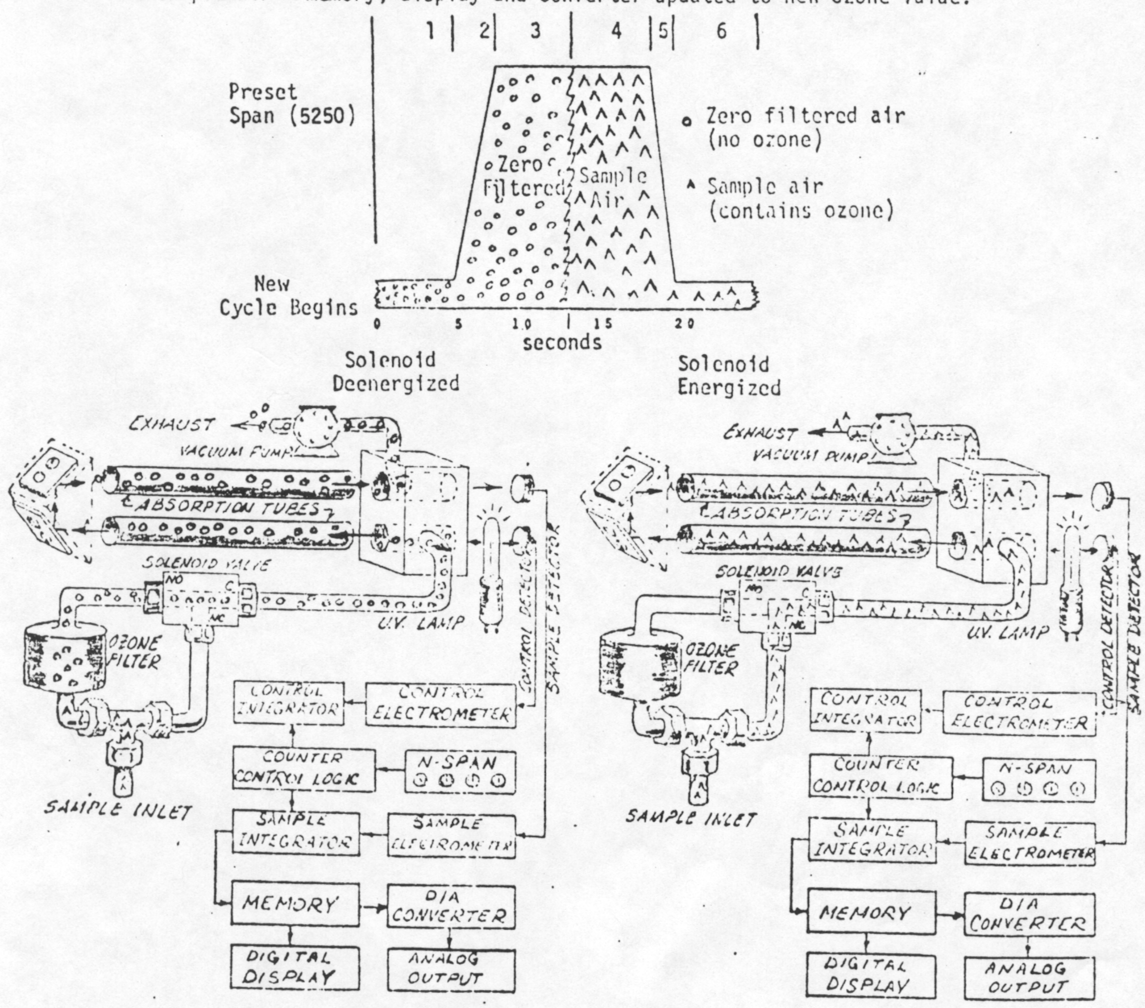


Figure A.1.0.1
Air Sampling Cycle

A.1.1 ROUTINE SERVICE CHECKS

A.1.1.1. GENERAL INFORMATION - Perform the following service checks routinely using the attached schedule (Table A.1.1.1) and the procedures documented in Section A.1.2. Checks may be performed more frequently, but should be performed at least at the prescribed intervals. Also, attached is a copy of the Monthly Quality Control Maintenance Checksheet (Figure A.1.1.1), which you should complete weekly and forward monthly to your supervisor.

A.1.1.2 DAILY CHECKS - Set the front panel flow meter to produce a standard flow of 2 to 3 SLPM, as indicated on the most recent calibration. Adjust, if necessary. Verify that the solenoid valve is cycling.

A.1.1.3 WEEKLY CHECKS - Record the initial and final readings on the Monthly Quality Control Maintenance Checksheet.

1. Sample Frequency - The sample frequency is proportional to the quantity of ultraviolet light passing through the absorption tubes and sensed by the sample detector. The sample frequency of a properly adjusted analyzer with a clean optical bench should be between 400 KHZ and 480 KHZ. With the function selector switch in "SAMPLE FREQUENCY", the display will indicate 48.000 at 480 KHZ. If the sample frequency drops below 400 KHZ, refer to procedures for cleaning and adjusting, given in Sections A.1.2.2 and A.1.2.3, respectively.

2. Control Frequency - The control frequency is proportional to the ultraviolet light sensed by the control detector adjacent to the source lamp. The control frequency of a properly adjusted analyzer should be between 210 and 280 KHZ. When the function selector switch is on "CONTROL FREQUENCY", the display will indicate 28.000 at 280 KHZ. The procedure for adjusting the control frequency is given in Section A.1.2.3.

3. Electronic Zero - Perform adjustments to the electronic zero using the procedures outlined in Section A.1.2.1. When the function selector switch is placed on "ZERO", the digital display should read 00.000 and the recorder chart should read negative. On "OPERATE", with the analyzer sampling through a zero filter, the display should read 00.010 $\pm$ .005 and the recorder should read 0.00. On the Checksheet, record the values obtained when the function selector switch is on "OPERATE".

4. Electronic Span - The Dasibi uses a standardized preset span setting of 525. With the function selector switch on "SPAN", the preset calibration setting of 525X should be displayed as 52.550 and read on the strip chart recorder as 54.0 $\pm$ 0.5% of full scale when the analyzer is operated on the

0 to 1.0 ppm full scale range, and the recorder at 0 to 1.0 volt. For analyzers operating at altitudes of 1,000 feet above sea level or greater, consult Section A.3.0.4 for the proper span setting. Perform adjustments to the electronic span using the procedure outlined in Section A.1.2.1.

5. Leak Checks - Set the front panel flow meter as indicated on the most recent calibration report to produce an actual flow rate of 2 to 3 SLPM. The flow should drop to zero when the analyzer's sample inlet is blocked. Otherwise, there is an air leak in the instrument. Procedures for leak checking are given in Section A.1.2.4.

6. Sample Particulate Filter - At least weekly, replace the in-line Teflon* sample particulate filter. Note the filter cleanliness and, if necessary, increase the replacement frequency. Change the filter if even a slight particulate coating or discoloration is visible. Note any unusual discolorations on the checksheet.

A.1.1.4 MONTHLY CHECKS

Monthly Quality Control Maintenance Checksheet - Monthly, after completing the final weeks checks, forward the Checksheet to your supervisor.

A.1.1.5 QUARTERLY CHECKS

Solenoid Valve - Using the procedure in Section A.1.2.4, leak check the solenoid valve. Record the test date on the Monthly Quality Control Checksheet. If the solenoid valve leaks, contact your supervisor to arrange for an as-is calibration prior to solenoid valve replacement.

A.1.1.6 SEMI-ANNUAL CHECKS

1. Ozone Scrubber - Do not replace ozone scrubbers without an accompanying calibration. The policy concerning ozone scrubber replacement is given in Appendix A.3, Section A.3.0.2. Record the date that the scrubber was replaced on the Monthly Quality Control Checksheet.

2. Multipoint Calibration - The ozone analyzer must be calibrated at least once every six months of operation, upon relocation, and after major repairs. One month prior to the recalibration due date, contact your supervisor to arrange for a multipoint calibration. Record the date of the most recent calibration on the Monthly Quality Control Checksheet.

* Trademark of Dupont Corporation.

TABLE A.1.1.1

Dasibi Model 1003-AH Ozone Analyzer Service Schedule

	Daily*	Weekly	Monthly	Quarterly	Semi-Annually
Sample Flow	X				
Solenoid Switching	X				
Sample Frequency		X			
Control Frequency		X			
Electrical Zero		X			
Electrical Span		X			
Leak Check		X			
Q.C. Check		X	X		
Sample Particulate Filter Replacement		X**			
Solenoid Leak Check				X	
Calibrations					X
U.V. Lamp Replacement As Required					
Solenoid Replacment As Required					
Cleaning Optics As Required					

* or each day the operator services the analyzer.
** or when required

CALIFORNIA AIR RESOURCES BOARD
MONTHLY QUALITY CONTROL MAINTENANCE CHECKSHEET
DASIBI MODEL 1003 AH OZONE ANALYZER

LOCATION: OILDALE
STATION NUMBER: 15-00230
ANALYZER PROPERTY NUMBER: 3903

MONTH/YEAR: 3/79
TECHNICIAN: JONES
AGENCY: ARB

DATE	SAMP FLOW SET-TING	DIGITAL OUTPUTS								CHART READING			
		PRE-SET SPAN SET-TING	SAMPLE FREQUENCY		CONTROL FREQUENCY		ZERO		ZERO		SPAN	
			AS FOUND	FINAL	AS FOUND	FINAL	AS FOUND	FINAL	AS FOUND	FINAL	AS FOUND	FINAL
2	4.5/5	5253	39360	-----	22230	-----	0	----	0	----	54	----
7	5/-	"	35693	44754	22110	25695	"	----	"	----	"	----
12	5/-	"	44250	----	25125	----	"	----	"	----	"	----
16	5/-	"	43996	----	24995	----	"	----	"	----	"	----
21	5/-	"	43901	----	24500	----	"	----	"	----	"	----
27	5/-	"	42250		24360	----	"	----	"	----	"	----
	/											
	/											

Operator Instructions:

1) Daily Checks: Airflow (record weekly), chart trace.
2) Weekly Checks: Electronic zero and span and corresponding chart readings, Sample and Control Frequencies, Leak test airflow system.
3) Quarterly Check: Leak check solenoid valve. Date tested: 3-27-79
4) Six month intervals: Ozone scrubber. Date last replaced: 11-19-78
   Calibration: Date of last calibration: 11-19-78
5) As required: Clean absorption tubes and mirrors.

DATE	COMMENTS OR MAINTENANCE PERFORMED:
7	CLEANED OPTICAL BENCH AND MIRRORS

TSD - 21(6/80) REVIEWED BY: AUGUSTU DATE: 4-6-79

Figure A.1.1.1
Monthly Quality Control Maintenance Checksheet

A.1.2 DETAILED MAINTENANCE AND ALIGNMENT PROCEDURES

The following adjustments are for an analyzer operating on a full scale range of 1.0 ppm and a recorder full scale response of 10 mv. The Dasibi may be used on the 0.5 ppm range. If so, appropriate adjustments must be applied.

A.1.2.1 ELECTRONIC ZERO AND SPAN - Adjust the electronic zero and span using the following procedure (all modes should record a minimum 10-minute trace). The analyzer's internal temperature should remain constant. Therefore, replace the cover immediately after adjustments are made.

1. Turn on the analyzer. Place the function selector switch to the "OPERATE" position and the "SPAN SET" switch to 5250. Install a carbon filter on the sample inlet port. Allow the analyzer to reach operating temperature.

   NOTE: In this configuration, the analyzer should have reached operation temperature when the digital display reads a steady non-zero value, usually .020 to .060, with $\pm$ .005 update repeatability.

2. Connect the signal output to a strip chart recorder with a digital voltmeter (DVM) in parallel. Adjust the sample flow rate to 2.5 LPM, as indicated by a Vol-o-Flo or the setting noted on the most recent calibration report.

3. Place the integrator switch on the D to A printed circuit board to the "OFF" (forward) position.

4. Adjust the "OFFSET ADJUSTMENT" switch (extreme right "SPAN SET" switch) so that the analyzer's digital display and the DVM indicate 00.010 $\pm$ 00.005 ppm and 00.10 $\pm$ 00.005 millivolt (mv), respectively.

5. After a stable recorder trace and DVM value are established (approximately 10 minutes), use the zero potentiometer on the D to A printed circuit board to adjust the analyzer output to read 00.000 to + 00.003 ppm on the recorder and 00.00 to + 00.03 mv on the DVM. Allow a stable 10-minute trace to be recorded.

6. Place the function selector switch to the "SPAN" position. The analyzer's digital display should read 52.550.

7. Adjust the recorder "SPAN" potentiometer on the front of the analyzer to obtain an output voltage of 5.40 $\pm$ 00.05 mv and a recorder trace of .540 $\pm$ .005 ppm.

8. After 10 minutes of stable recorder trace, turn the function selector switch to the "OPERATE" position.

9. While still sampling filtered zero air, the recorder and DVM should return to 00.000 + 00.003 ppm and 00.00 + 00.03 mv, respectively. If not, readjust the analyzer as outlined in Steps 4, 5, 6, and 7.

10. When the output voltages (zero and span) are stable and repeatable, set the integrator switch on the D to A printed circuit board to the "ON" (rear) position.

11. Place the function selector switch to "SPAN" to allow the analyzer to reach a stable span of 5.40 $\pm$ 00.05 mv as read on the DVM and .540 $\pm$ .005 ppm on the recorder.

12. After a stable recorder trace is established, turn the selector switch to the "OPERATE" position. The output voltage should return to 00.00 to + 00.03 mv on the DVM and 00.000 to + 00.003 ppm on the recorder. The analyzer's digital display should indicate 00.010 $\pm$ 00.005 ppm.

13. Remove the zero filter from the sample inlet and the DVM from the recorder output terminals.

14. If the analyzer is in an ambient air monitoring site, connect the sample inlet port to a glass or teflon manifold and initiate sampling. If not, turn off the power switch, cap the inlet and exhaust ports and secure for storage.

NOTE: When the function selector switch is placed in the "ZERO" position the chart will indicate below zero; in the "OPERATE" function, the display will indicate .010 $\pm$.005 (from Step 5) greater than the chart.

A.1.2.2 OPTICS - Dirt, smoke, and filmy material drawn in with the ambient air sample will cloud the optics of the analyzer. As time passes, the sample, and sometimes control frequencies will decrease. This can be corrected by periodically cleaning the optical bench, mirrors, and detector windows, and repositioning the lamp and/or detectors. A properly cleaned and aligned analyzer, equipped with a 1 MHZ crystal, will have a sample frequency of ~480 KHZ and a control frequency of ~280 KHZ. Proper procedures for cleaning the optics are given in the Manufacturer's Instruction Manual.

NOTE: Sample frequency of 500 indicates a saturated detector and requires detector and/or lamp repositioning.

A.1.2.3 ADJUSTING SAMPLE AND CONTROL FREQUENCIES - Sample and control frequencies decrease as dust and dirt particles collect throughout the optical path, as the UV lamp output decays, or as the efficiency of the detectors diminish. When cleaning and adjusting procedures fail to restore the frequencies to adequate levels, replacement of the UV lamp and/or electrometer board and both detectors is necessary. The sample control frequencies are adjusted by using the following procedure:

1. General Information

   a. The frequency of the other detector is not affected by this realignment.

      NOTE: Care should be taken not to short the detector terminals on the 15 volt power supply.

   b. If both frequencies are low, realign or replace the UV source to bring both frequencies up to specification (sample frequency 400 to 480 KHZ - control frequency 210 to 280 KHZ). The detectors and/or lamp can be moved either in or out, and turned either clockwise or counterclockwise until the desired frequency is attained. Sliding the UV source further into the source clock will increase frequencies. Rotating the lamp may either increase or decrease the frequencies independently.

   c. Early model analyzers have a lamp voltage control pot on the power supply board. Generally, the lamp drive is set at 24 VDC. Increasing this voltage causes an increase in lamp intensity and a cooresponding increase in both sample and control frequencies.

2. Sample Frequency Adjustment

   a. If the analyzer has been off, allow at least thirty (30) minutes for warm-up before checking the frequency.

   b. Place the function selector switch to the "SAMPLE FREQUENCY" position.

   c. Sample frequencies should be between 400 KHZ and 480 KHZ (displayed 40.000 and 48.000, respectively) when the optics are clean. If the analyzer doesn't meet the specifications, make the following adjustments:

      (1) Connect a frequency counter to the sample frequency and ground pins on the logic board. If a frequency counter is not available, use the analyzer's digital display.

      (2) Loosen the ultraviolet (UV) lamp lock screw and reposition the lamp until the frequency is within specifications. Sliding the UV lamp into its socket increases the frequency and sliding it out decreases the frequency. Carefully tighten the UV lamp lock when adjustments are complete.

      (3) Further adjustment can be made by repositioning the sample detector. To accomplish this, loosen the set screw holding the detector and slide the detector in to increase and out to decrease the frequency. Tighten the set screw securely after adjustment is complete.

3. Control Frequency Adjustment

   a. If the analyzer has been off, allow at least thirty (30) minutes for warm-up before checking the frequency.

   b. Place the function selector switch to the "CONTROL FREQUENCY" position.

c. With clean optics and a good lamp, control frequencies should be between 210 KHZ and 280 KHZ (displayed 21.000 and 28.000, respectively). If the analyzer doesn't meet these specifications, make the following adjustments:

(1) Connect a frequency counter to the control frequency and ground pins on the logic board or, if a frequency counter is not available, use the analyzer's digital display.

(2) Step 2c(2) will have affected the control frequency as well as the sample frequency. Further control frequency adjustment can be made by loosening the control detector set screw and then sliding the detector either in to raise, or out to lower the frequency.

(3) Tighten the control detector set screw securely and recheck both sample and control frequencies.

A.1.2.4 LEAK CHECKS (SOLENOID SYSTEM)

Leak check the solenoid valve before the analyzer is placed into operation and quarterly thereafter. After the solenoid is found free of leaks, a full system leak check is made. The leak checks are accomplished as follows:

1. Turn off the analyzer power and disconnect the power cord.

2. Disconnect the inlet tubing at the station manifold and plug the manifold to prevent leakage of room air into the probe. Cap off the sample inlet to the analyzer.

3. Remove the analyzer cover and the ozone scrubber.

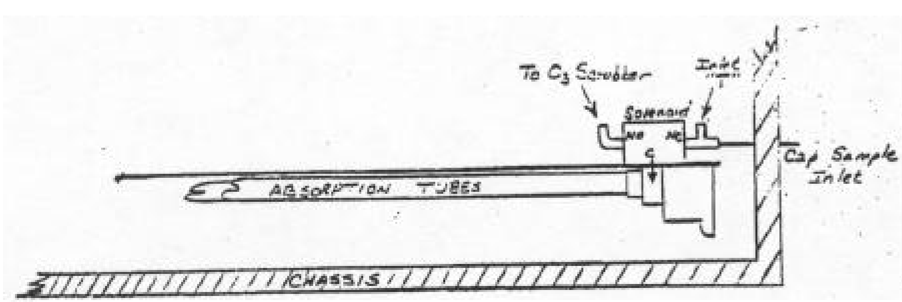
4. Connect the outlet of a flow meter (0.05 to .5 SCFH), or equivalent, to the normally open (NO) port of the solenoid valve. Reconnect the power cord and turn on the power. The flow meter should indicate zero air flow during the last 10 seconds of the analysis cycle. Disconnect the flow meter from the NO port

5. Turn off the analyzer power and disconnect the power cord. Connect the outlet of a flow meter (0.05 to .5 SCFH), or equivalent, to the normally closed (NC) port of the solenoid valve at the open leg of the inlet tee. Reconnect the power cord and turn on the power. The flow meter should indicate zero air flow during the first 10 seconds of the analysis cycle. If flow is present during the first ten seconds of the analysis cycle, replace the solenoid valve. However, see Section A.1.1.5 regarding an "As Is" calibration prior to actual solenoid valve replacement.

6. Turn off the analyzer power and disconnect the power cord. Disconnect the flow meter from the NC port of the solenoid. Reinstall the ozone scrubber and leak check the entire air system as follows:

   a. Reinsert the power cord and turn on the power. Cap off the sample inlet or block it with your finger during a complete analysis cycle. The analyzer's flow meter should drop to zero after a couple of analysis cycles. If not, find and repair the leak.

   b. Reinstall the analyzer cover and reconnect the sample inlet to the station manifold.



A.1.3 TROUBLESHOOTING

A.1.3.1 GENERAL INFORMATION - The Dasibi Instruction Manual contains information pertaining to preventive maintenance, troubleshooting, and corrective maintenance. The Dasibi manual should be your first source of information for performing maintenance and troubleshooting. Additional problems which have occurred and are not discussed in the Dasibi manual are outlined here. Malfunctions can be grouped into one of four types: Electrical, optical, flow, or peripheral equipment malfunctions. It is suggested that each station operator compile personal notes on troubleshooting as they gain experience with the Dasibi. Space is provided on the monthly QC Checksheet for recording malfunctions, causes, fixes, and actions taken to prevent reoccurrence.

Cautions listed in Section A.1.0.3 should be observed. Additionally, when removing or installing printed circuit boards or other components, turn the analyzer off and remove the power cord.

A.1.3.2 ELECTRONIC MALFUNCTIONS

Problem	Probable cause	Fix
Chart zero not in Agreement with Digital (display 00.000)	Digital to Analog (D-A) converter zero not properly adjusted	Adjust chart zero with the zero pot on The D-A board. For Dasibi with offset, review procedure in Section A.1.2.1.
Chart span not in agreement with digital display	Analog span pot improperly adjusted	Adjust the analog span pot on the front of the analyzer until recorder is in agreement with the display. For analyzer w/ offset (Sec A.1.2.1).

Problem	Probable Cause	Fix
Analyzer operating Without digital display	200VDC power supply (P.S.) inoperative	Remove the load from the P.S. and check Voltage. If voltage Reads 200VDC, then the problem may exist In the plug-in-display elements. Unplug the display and recheck the voltage. If the problem is in the display, replace the element.
When the digital display reads zero (00.000), the recorder	D-A converter loose	Turn off the analyzer power. Reinsert the D-A converter into its plug making sure of proper alignment. Turn on power.
	+/-15VDC P.S.	Remove all loads on the +/-15VDC supply. If the voltage checks, plug in one load at a time until the problem with the circuits is found and then corrected.
Dead system, no display, fan not running, etc.	Blown fuse	Turn off power switch Check fuse and replace as needed.
	Power cord loose/Disconn.	Reinsert power cord.

Problem	Probable cause	Fix
Erratic output indicated by recorder	Loose recorder leads	Tighten leads
	U.V. Source lamp instability	Check the source heater which should be 52^{o} C. Adjust or replace as necessary. Secure lamp and/or detectors in source block. Check stability of 25VDC lamp drive on P.S. board. Check lamp drive. Replace lamp.
	Electrometer noise	Replace electrometer assembly. Check 5 volt P.S. and replace regulator if required.
Recorder trace periodically goes to zero and remains there for a period of time, and then returns to ambient O_3 readings	Solenoid not switching	Check the input and output signals at the solenoid driver card. Replace card if necessary.

A.1.3.3 OPTICAL MALFUNCTIONS

Problem	Probable cause	Fix
Erratic trace on the recorder	Dirty optics	Clean the optical bench, mirrors, etc.
Loss of sample control frequency	Faulty Detector	Replace the electrometer assemble.
Unstable sample or control frequency	Loose lamp or detector	Replace the lamp.
Analyzer shows excessive temperature drift	Faulty lamp	Check the source block temperature (52°C). Repair circuit or replace the heater.

A.1.3.4 FLOW MALFUNCTIONS

Problem	Probable cause	Fix
Analyzer indicates low values when sampling span gas	Faulty ozone catalyst (scrubber)	Change the scrubber.
Zero O_3 ouput when monitoring ambient air	Pump stopped	Check the power to pump and change the pump if necessary.
Recorder trace erratic when analyzer is sampling	Loose absorption tubes	Tighten the absorption tubes, checking O-rings for proper seals.
	Leaks in flow system	Leak check the entire system and correct as required.
	Improper bypass flow at calibrator	Reset flow at calibrator.

A.1.3.5 PERIPHERAL EQUIPMENT MALFUNCTIONS

Problem	Probable cause	Fix
Lost or noisy trace	Loose wire from analyzer output to the recorder	Tighten the recorder leads at the analyzer and the recorder.
	Dead recorder amplifier	Check the recorder response using a multivolt potentiometer. Verify the response with a digital multimeter in parallel with the recorder. Check amplifier gain and adjust as required.
Non-linear response	Improper zero and span of analyzer and/or recorder	Zero and span analyzer electronics. Place analyzer function mode switch to span and check recorder tracking by resetting preset span switches. Recorder should track the preset span.
	Miswired D-A converter	Independent checks of the recorder in step, above, shows that the recorder response is linear. Now trace out the wiring and rewire the D-A converter P.C. board, if necessary. Reset preset span to correct setting after troubleshooting.

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX A.2

ACCEPTANCE TEST PROCEDURE

FOR

DASIBI MODEL 1003 AH OZONE ANALYZER

MONITORING AND LABORATORY DIVISION

JANUARY 1986

A.2.0 PROCEDURE

A.2.0.1 GENERAL INFORMATION - Before beginning acceptance testing of the analyzer, read the manual thoroughly. Then, initiate an instrument log book and an acceptance test mini-report (Figure A.2.0.1).

A.2.0.2 PHYSICAL INSPECTIONS - Unpack the analyzer and check for physical damage. Remove the top cover from the analyzer and perform the following checks:

1. Remove and reinsert printed circuit boards.

2. Check for correct power cord phasing; standard wiring configuration has black wire connected to the brass terminal of the plug, white to copper and green to earth ground. Verify the analyzer chassis is grounded to earth ground.

3. With the analyzer power off and the A.C. power cord unplugged, connect the pressure side of an external pump (MB-41 or equivalent) to the exhaust fitting on the rear of the analyzer; cap off the sample inlet and pressurize the system. Using "Snoop" sparingly, leak check the entire flow system. After repairing leaks and before applying power, thoroughly dry the entire system.

4. Verify that the analyzer is complete upon receipt (i.e., manuals, rack mount slides, etc.).

A.2.0.3 OPERATIONAL TESTS - Perform the following operational checks and record the results on the strip chart and mini-report. Retain the charts in the Air Quality Surveillance files as a permanent record of the tests performed.

1. Analyzer Alignment

   a. Connect the power cord to the analyzer and turn on the power. Measure the power supply voltages and record the readings on the "mini-report" and strip chart.

b. Measure the temperature of the UV source block (52ºC + 1ºC) and record the value on the mini-report and the strip chart.

c. Clean the optics using the procedure outlined in the manufacturer's manual.

d. Adjust the sample and control frequencies, if necessary, using the procedure outlined in Section A.1.2.3 of Appendix A.1.

e. Zero and span the electronics using the procedure outlined in Section A.1.2.1 of Appendix A.1.

2. Electrical Test Modes - Operate the analyzer for 20-30 minutes at each of the following test switch settings: sample, control, zero, and span. Check each mode for a stable trace and correct noted malfunctions.

3. Digital-to-Analog Signal Integrator Test (Disregard this test for units without a signal integrator on the DA Board).

   a. With the integrator off, obtain a span trace on the recorder at approximately 90% of the full scale. When a stable trace is established, switch the integrator "on" and verify that there is not a variance from the original setting after restabilization.

   b. With the integrator on, establish a stable zero trace on the recorder. Then, switch the analyzer to the "SPAN" mode and check the time required for the recorder trace to reach 90% of the span setting (i.e., 90% of 0.90 = 0.81). The trace should reach 90% within 5 minutes.

   c. Sample outside (ambient) air for 24 hours with the integrator off and then with the integrator on. Correct any problems noted.

4. Zero and Span Drift

   a. Establish stable zero and span (~.8 ppm O_3) traces on a strip chart recorder using appropriate repeatable sources.

   b. At intervals of 24 hours and 72 hours, repeat the above zero and span points. Deviations should not exceed $\pm$.01 ppm for 24 hours or $\pm$.02 for 72 hours.

5. Line Voltage Test - Vary the input line voltage from 105 VAC to 125 VAC in 5 volt increments (115 VAC, 110 VAC, 105 VAC, 110 VAC, 115 VAC, 120 VAC, 125 VAC, 120 VAC, 115 VAC) while sampling a constant concentration between 0.5 ppm to 0.8 ppm O_3. Remain at each step at least 10 minutes. Deviations should not exceed $\pm$.01 ppm.

6. Temperature Test - Place the analyzer in the environmental chamber. Establish a stable recorder trace utilizing a known concentration between 0.5 ppm to 0.8 ppm O_3. Vary the ambient temperature from 4ºC to 44ºC in 5ºC intervals. Repeat the test while sampling zero air in both instances; full scale deviations should be less than $\pm$.01 ppm.

7. Sample Flow Variation Test - With a known concentration of ozone being sampled by the analyzer, vary the true sample flow from 1.0 SCFH (.5 LPM) to 6 SCFH (2.9 LPM). Observe and record any variation in readings due to sample flow changes. Investigate changes in the recorder trace of more than $\pm$.01 ppm between flow settings of 3.2 SCFH (1.5 L/M) to 6 SCFH (2.9 L/M). The most common problems are leaks and faulty 0_3 scrubbers.

8. Calibration - Perform a multipoint calibration on the analyzer using calibration procedures outlined in Appendix A.3. This also represents the linearity portion of the acceptance test.

9. Final Review - If the tests are satisfactory, complete an equipment relocation notification and record pertinent information such as final sample flow, final sample and control frequencies, etc. in the log book and on the acceptance test mini report. The analyzer is now ready for field use.

BENDIX MODEL 8501-5CA CARBON MONOXIDE ANALYZER
ACCEPTANCE TEST "MINI REPORT"

Date____________________ Serial No.________________ Reviewed by______________
By_____________________ ARB No.________________ Date of Acceptance________

I. PHYSICAL INSPECTIONS

	Pass	Fail	Final OK
A. *Checked for shipping damage..*	____	___	________
B. *Checked all electrical wiring..*	____	___	________
C. *Checked all plumbing for leaks..*	____	___	________
D. *Analyzer complete upon receipt..*	____	___	________

II. OPERATIONAL TESTS (All tests performed on 0-100ppm full scale)

A. *Analyzer Alignment. Measure voltage at:(TP2)0±10mV__mV(TP6)<50mV__mV*

	%FS Dev.	Pass	Fail	Final OK
B. *Electrical modes...*	_________	____	___	________
C. *Zero and Span Drift*				
1. *24 Hour Zero Drift...........................*	_________	____	___	________
2. *24 Hour Span Drift @______ ppm.*	_________	____	___	________
3. *72 Hour Zero Drift...........................*	_________	____	___	________
4. *72 Hour Span Drift @______ ppm..*	_________	____	___	________
D. *Line Voltage Test(105-125 VAC @__ppm)..*	_________	____	___	________
E. *Temperature Test*				
1. *Zero Shift: Step 1 __EC to __BC...*	_________	____	___	________
Step 2 __EC to __EC...	_________	____	___	________
Step 3__EC to__ EC...	_________	____	___	________
2. *Span@ __ppm Step 1__EC to__ EC...*	_________	____	___	________
Step 2__EC to__ EC...	_________	____	___	________
Step 3__EC to__EC...	_________	____	___	________
F. *Sample Flow Variation Test @____SLPM....*	_________	____	___	________
G. *Linearity*				
1. *⊆80% Full Scale @______ppm......*	_________	____	___	________
2. *⊆40% Full Scale @______ppm......*	_________	____	___	________
3. *⊆20% Full Scale @______ppm......*	_________	____	___	________
4. *⊆10% Full Scale @______ppm......*	_________	____	___	________
H. *Interference Tests*				
1. *Carbon Dioxide (CO_2).....................*	_________	____	___	________
2. *Water Vapor (H_2O) ....*				

I. *Final Analyzer Readings*
Sample Flow:______ SCCM @_______Flow Setting; Pump Pressure______psig;
Zero Pot___________; Span Pot___________; Range____________ppm.

III. SPECIAL TESTS

IV. COMMENTS/MAINTENANCE PERFORMED

Figure A.2.0.1
Dasibi Model 1003 AH Acceptance Test "Mini Report"

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX A.3

CALIBRATION PROCEDURE

FOR

DASIBI MODEL 1003-AH OZONE ANALYZER

MONITORING AND LABORATORY DIVISION

MAY 1985

A.3.0 PROCEDURE

A Dasibi Model PC or 1008 PC ozone analyzer/calibrator (transfer standard), or equivalent, standardized against a primary standard laboratory ultraviolet photometer is used in calibrations. The response of the analyzer being calibrated is compared to the response of the transfer standard.

A.3.0.1 APPARATUS

1. Dasibi Model 1003 PC or 1008 PC ozone analyzer/calibrator
2. One-quarter inch Teflon* tubing for air flow connections
3. Charcoal zero air scrubber (Gelman Model No. 12011, or equivalent)
4. Calibrated laminar flow device for measuring air flow (Vol-o-Flo, or equilivant)
5. Spare ozone scrubber
6. Calibration report forms (Figures A.3.0.1, A.3.0.2, and A.3.0.3)

A.3.0.2 OZONE SCRUBBER REPLACEMENT - The policy concerning ozone scrubber replacement is as follows:

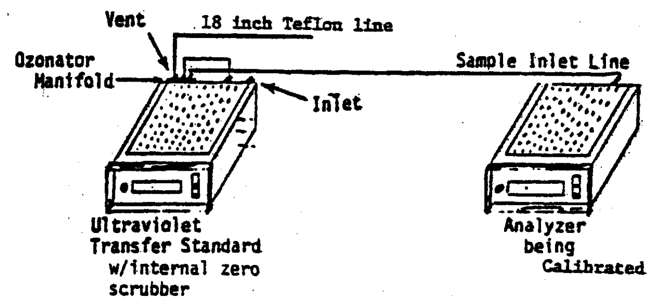
1. Replace ozone scrubbers only at the time of calibration, and only after performing an “As Is” calibration. After replacing an ozone scrubber, perform a multipoint calibration.
2. No field scrubber replacement is required for seasonal ozone monitoring. At the end of the ozone season, return the analyzer to the AQM Support Facility for overhaul. The overhaul includes scrubber replacement and a multipoint calibration check.
3. For analyzers operating continuously for a full year, replace the ozone scrubber during the pre-ozone season calibration. Although recommened, it is not necessary to replace the ozone scrubber during the post-season calibration, but continue semi-annual replacements.

* Trademark of Dupont Corporation.

A.3.0.3 "AS IS" CALIBRATION - Other than routine checks, analyzer repairs or adjustments should not be made prior to the "As Is" calibration.

NOTE: The ozone scrubber and solenoid valve should not be replaced without first performing an "As Is" calibration.

1. Assemble the equipment as per the schematic below and allow zero air to flow through the system.



2. While sampling zero air, allow both the transfer standard and the analyzer being calibrated to warm up for at least one hour. The covers of both instruments should be on during the calibration, as the calibration is dependent upon the internal temperature of the analyzer. The control frequency readings should be stable, showing no upward or downward trend when the analyzer has reached operating temperature. The transfer standard is equipped with a positive offset feature. Set the transfer standard offset dial to zero allowing for the full 50 ppb offset.

3. Record the analyzer identification numbers, analyzer settings and any other pertinent information on the calibration worksheet.

4. Adjust the sample air flow rate of the transfer standard to 2.5 SLPM, as measured by the calibrated laminar flow device. Measure and record the "as is" sample air flow rate of the analyzer being calibrated. Adjust the sample air flow rate on the Dasibi to be calibrated to the normal setpoint indicated on the most recent Monthly Checksheet and then determine the flow using the laminar flow device. Record the flow meter settings and true air flow on the calibration worksheet. Connect an 18-inch long Teflon line (1/4" 0.D.) to the vent port of the transfer standard and measure the vent flow. The vent flow should be greater than 0.5 LPM.

5. While the analyzer and transfer standard are sampling zero air, record 10 consecutive digital display values in the respective columns labeled "pre-zero". Calculate the sum and average of the 10 numbers and record the

value on the calibration worksheet in the respective blocks. Record the average strip chart (and/ or other data acquisition system) reading in the space provided.

6. Set the lamp intensity control of the transfer standard to produce an ozone concentration of approximately 0.8 ppm 0_3 as read by the transfer standard.

7. Record 10 consecutive digital values in the columns labeled "1st pt" for each analyzer. Calculate the sum and average of the 10 numbers and record the value on the calibration worksheet in the appropriate blocks. Record the average strip chart recorder (and/or other data acquisition system device) reading in the appropriate space.

8. Record data for the "2nd Pt", "3rd Pt", and 4th Pt": after adjusting the ozone generator output to approximately 0.40, 0.20, and 0.10 ppm, respectively, calculate and record the sum and average readings.

9. Repeat step 5 and record the value in the volumes marked "post- zero". Average the "pre-zero" and "post-zero" readings and use this value as the zero correction.

10. Calculate corrected averages for the transfer standard analyzer using the formula:

    Corrected Average (Transfer Standard)=(Average Reading - Zero Correction) x True Ozone Correction Factor x Altitude Correction Factor (see Table A.3.0.1 for altitude correction factors applicable to Model 1003 PC only; Model 1008 PC requires no altitude correction, therefore, use a factor of 1.000 at all altitudes).

11. Calculate the summation of corrected averages for the transfer standard (S_1) by adding the corrected averages for points 1, 2, 3, and 4.

12. Calculate the corrected averages of the analyzer being calibrated using the formula:

    Corrected Average = Average Reading - Zero Correction

    Note: If a strip chart recorder or Data Acquisition System is used for primary data recording, then that data should be used in the calculations instead of the meter readings.

These values, in ppm, should correspond to the analyzer's digital display. If not, check the calibration of the recording device before making adjustments to the analyzer.

13. Calculate the summation of corrected averages for the analyzer being calibrated (S_2) by adding the corrected averages for points 1, 2, 3, and 4.

14. Calculate the average percent difference from true ozone:

$$\text{Percent deviation from true ozone} = \frac{S_2 - S_1}{S_1} \times 100\%$$

15. Using a best fit linear regression, calculate the slope (m) and intercept (b) equation of the calibration line:

Where x = true concentration, in ppm
y = analyzer response, in ppm

16. Calculate the percent change from the previous calibration:

Percent change from the previous calibration =

$$\frac{\text{New Slope - Old Slope}}{\text{Old Slope}} \times 100$$

17. Record the requested information on the front of the calibration report.

A.3.0.4 "FINAL" CALIBRATION - If the percent difference reported in Section A.3.0.2.14 is outside ±100%, or if the ozone scrubber is replaced (see Section A.3.0.2), repeat the calibration beginning with Step 3. Refer to Section A.1.3 - Troubleshooting, and to the Dasibi Instruction Manual for assistance in troubleshooting and repairing the analyzer.

A.3.0.5 CALIBRATING DASIBI OZONE ANALYZERS FOR OPERATING AT HIGHER ELEVATIONS (GREATER THAN OR EQUAL TO 1,000 FEET ABOVE MEAN SEA LEVEL)

1. The span setting of the analyzer being calibrated must be corrected to standard pressure for the altitude of operation. Use Equation A and Table A.3.0.1 to calculate the new span setting (N.S.).

   Equation A: N.S. = 525X x Altitude Correction Factor (ACF)
   where 525X is the standard span setting

2. The span setting of the transfer standard is not to be adjusted for altitude. The altitude correction factor is to be applied when calculating the corrected averages of the transfer standard on the ozone calibration work sheet;

   i.e., Corrected Average (Transfer Standard) = Average Reading - Zero Correction x True Ozone Correction Factor x ACF

3. Calibrate the analyzer as in Section A.3.0.2.

Table A.3.0.1
Span Correction With Altitude

Elevation (Feet above sea level)	Altitude Correction Factor (ACF)	Correct Span Setting
0	1.000	525X
500	1.000	525X
1000	1.037	545X
1500	1.056	555X
2000	1.075	565X
2500	1.095	575X
3000	1.116	585X
3500	1.136	595X
4000	1.158	605X
4500	1.179	615X
5000	1.202	635X
5500	1.225	645X
6000	1.248	655X
6500	1.272	665X
7000	1.296	685X
7500	1.321	695X
8000	1.347	705X
8500	1.372	725X
9000	1.399	735X
9500	1.426	745X
10000	1.454	765X

CALIFORNIA AIR RESOURCES BOARD
CALIBRATION REPORT

TO: Manager - Air Monitoring Section Central
LOG NUMBER:
CALIBRATION DATE: 4-25-85
FROM: Lou Johns
REPORT DATE: 5-1-85

IDENTIFICATION

Instrument: DASIBI OZONE ANALYZER	Site Name: Santa Barbara-Canon P
Model Number: 1003 AH	Site Number: 42-378
Property Number: ARB 3956	Site Location: Canon & P Sts.; S.B.
Serial Number: 1384	
Previous Calibration Log Number:	Instrument Property of: ARB
Elevation: 80' Site Temp.: 24.1EC	Barometric Pressure: 29

CALIBRATION STANDARDS

Standard	I.D. Number	Certification Date	Certified Value or Factor
DASIBI 1003 PC	3407	3-12-85	.994

CALIBRATION RESULTS

Component	O_3		
Instrument Range, ppm	0-1ppm		
Initial Zero Setting	4		
Initial Span Setting	525		
Air Flow Rate, SLPM	2.5		
Air Flow Setting	3		
Reagent Flow Rate, SCCM	NA		
Reagent Flow Setting	NA		
Converter Efficiency	NA		
Best Fit Linear Regression Slope, Intercept (x= True y= Net chart)	.978, - 0.003		
"As Is" Deviation from True	NA		
"Final" Deviation from True	-4.9		
Change from Previous Calibration, %(date 10-1-84)	-4.1		
Final Zero Setting, Final Span Setting	4, 525		

Comments

Calibrated By Franklin Checked By johns

Figure A.3.0.1
Calibration Report

CALIFORNIA AIR RESOURCES BOARD
OZONE ANALYZER CALIBRATION DATA SHEET
Page 1 of 2

CALIBRATION: AS IS [ ] FINAL [ ]
DATE ______ LOG NO. ______
SITE ELEVATION ______ (feet)
ALTITUDE CORRECTION FACTOR* ______

SITE NAME ______
SITE NUMBER ______
SITE TEMPERATURE (°C) ______
BAROMETRIC PRESSURE (" Hg) ______

TRANSFER STANDARD

Make and Model ______
Property No. ______
Sample Freq. (Display) ______ (initial) ______ (final)
Control Freq. (Display) ______ (initial) ______ (final)
Air Flow: ΔP ______ Flow ______ slpm @ ______ Flow Setting
Span Dial Setting ______ Display ______ Offset ______
True Ozone Correction Factor (TOCF) ______ Certification Date ______

ANALYZER BEING CALIBRATED

Make and Model ______ Prop. No. ______
Serial No. ______ Cycle Time ______ seconds
Sample Freq. (Display) ______ (initial) ______ (final)
Control Freq. (Display) ______ (initial) ______ (final)
Air Flow: ΔP ______ Flow ______ slpm @ ______ Flow Setting
Span Dial Setting ______ Display ______ Offset ______
Flow Measurement Device: Type ______
Prop. No. ______ Calib. Date ______

Pre-Zero	1st Pt.	2nd Pt.	3rd Pt.	4th Pt.	Post-Zero		Pre-Zero	1st Pt.	2nd Pt.	3rd Pt.	4th Pt.	Post-Zero
						1						
						2						
						3						
						4						
						5						
						6						
						7						
						8						
						9						
						10						
						Average Display						
						Strip Chart Recorder						
						Data Acquisition System (ppm)						
						Corrected Average ** (ppm)						

* Altitude Corrected Factor = .999 x exp (.0000371 x Altitude, feet) if Altitude > 1000 feet; otherwide = 1.000 (Note: Altitude Correction Factor $\geq$ 1).

** Corrected Average (Transfer Standard) = [Average Reading - $(\frac{\text{Pre-Zero + Post-Zero}}{2})$] x TOCF x Altitude Correction Factor

** Corrected Average (analyzer being calibrated) = Average Reading - $(\frac{\text{Pre-Zero + Post-Zero}}{2})$

ADD-23 (1/84) Calibrated by ______ Checked by ______

Figure A.3.0.2
Ozone Analyzer Calibration Datasheet

CALIFORNIA AIR RESOURCES BOARD

OZONE ANALYZER CALIBRATION DATASHEET
Page 2 of 2

Site Name:___________________________ Calibration: As Is__________ Final_________
Site Number:_________________________ Date:__________________________________
Log Number:___________________________

Sum of Corrected Averages (Transfer Standard), S_1 = ___________________________(ppm)

Sum of Corrected Averages (Analyzer Data Acquisition System, DAS):
S_2 = _____________(ppm)

Percent Deviation from True = $\frac{S_2 - S_1}{S_1}$ x 100% = ________%

Linear Regression:

Analyzer Response (DAS), ppm = (__________) x True O_3 Conc.$\pm$(__________)ppm
Slope Intercept

As Is Change From Previous Calibration Dated__________________:

$\frac{\text{(As Is Slope - Old Slope)}}{\text{Old Slope}}$ x 100% = (____________) x 100% = ____________%

Comments:____
____
____
____
Calibrated by__________________________ Checked by____________________

Figure A.3.0.2 (cont.)
Ozone Analyzer Calibration Datasheet

CALIFORNIA AIR RESOURCES BOARD

CALIBRATION GRAPH

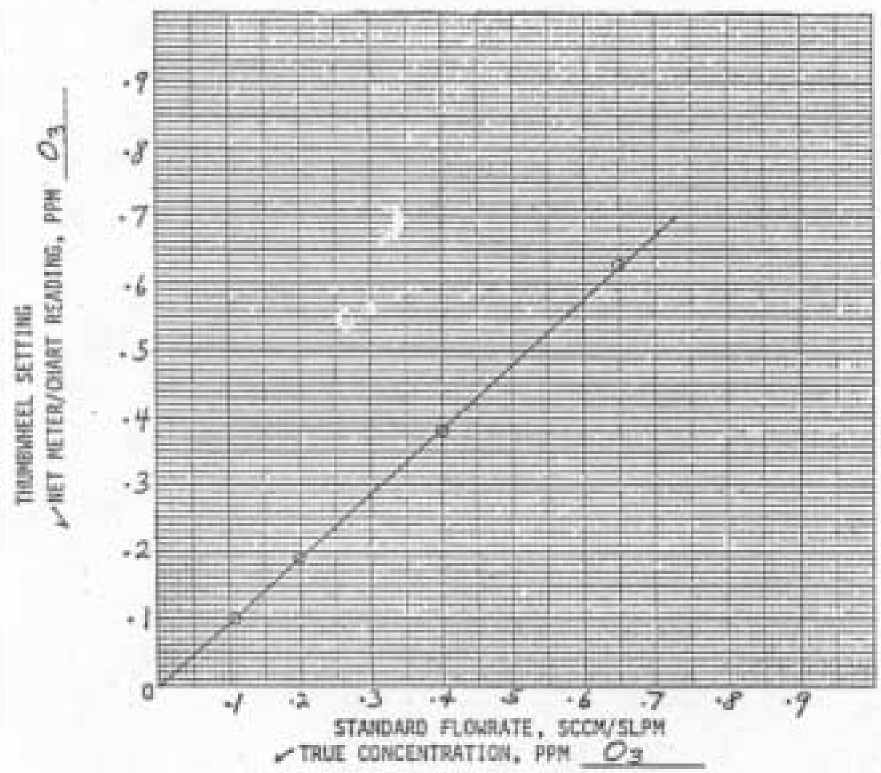
Log No.: ____________

Station Name: SANTA BARBARA Date of Calibration: 3-1-79

Station Site No.: 42-355 "As Is" Calibration: ____________

Instrument Property No.: 3958 Final Calibration: ✓

Instrument Make and Model No.: DASIBI 1003 AH



COMMENTS: ____________

Figure A.3.0.3
Calibration Curve